Analysis of Land and Water Use in Relation to Groundwater Conditions in Colusa County

An Executive Summary of a Technical Presentation to a Joint Meeting of the Colusa County Board of Supervisors and Groundwater Commission

January 19, 2016

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Introduction

Davids Engineering has been engaged by the County of Colusa to provide technical services supporting the County's efforts, working with other local agencies, to implement California's new Sustainable Groundwater Management Act (SGMA). According to its initial scope of services, Davids Engineering's efforts have focused on the part of the County where groundwater levels have declined in recent years. Davids Engineering will be presenting the findings of its technical analysis to a joint meeting of the County Board of Supervisors and Groundwater Commission on January 19, 2016. This document provides a brief summary of that presentation, organized by Objectives, Methodology and Findings and Conclusions.

Objectives

The main objectives established for the analysis are to identify factors potentially contributing to recent groundwater level declines. Additionally, based on the presumption that both changing land use and recent drought conditions are contributing to groundwater level declines, the County is interested in understanding the relative importance of these factors.

Methodology

The analysis began with a review of recent historical groundwater levels using publicly available groundwater data published by the Department of Water Resources. Additionally land use and weather records were reviewed. Based on this review, the area designated by the dashed outline in Figure 1 (see last page) was designated as the "area of interest" (AOI). Detailed water budgets were prepared for the AOI that describe, among other parameters, the amounts of water exchanged between the land surface and the underlying groundwater system.

The parameter "Net Recharge" was calculated from the water budgets representing the sum of all downward flows into the groundwater system (deep percolation of precipitation, deep percolation of applied irrigation water and stream seepage) minus the upward flow via groundwater pumping. Thus, Net Recharge represents the net contribution of hydrologic processes in the surface layer to storage of water in the underlying groundwater system. Net Recharge was analyzed with respect to different land use categories and, within the irrigated lands, for areas with different water supply sources. These included areas irrigated primarily with surface water, areas irrigated with a mix of surface water and groundwater, and areas irrigated primarily with groundwater. Comparisons of Net Recharge were made for the current "dry" period during which groundwater levels have declined, and for a preceding "normal" period during which groundwater levels were generally steady.

The effects of land use changes were differentiated from changes in "other factors" affecting the water budgets by recalculating the water budget for the dry period assuming land use from the preceding normal period, as if land use changes that have actually occurred in recent years had not occurred.

Findings and Conclusions

The main findings of the analysis follow. Supporting graphics can be found in the PowerPoint presentation that is under preparation for January 19. There are many additional details that are not documented here.

1) Analysis of precipitation records within the AOI from 1986 through 2015 indicate that the ongoing dry conditions actually date back to about 2007, with annual precipitation totals below the long-term average in seven of nine years since 2007.

2) Inspection of groundwater well hydrographs (plots of historical groundwater levels) generally display the following:
    a. Recovery during the early 1980s (which is generally attributed to the beginning of supplemental surface water deliveries via the Tehama-Colusa Canal and consequent reduction of groundwater pumping)
    b. Stable trends from the mid 1980's to mid 2000's
    c. Declining trends from the mid/late 2000's to the present time

3) Current (Fall 2015) groundwater levels in most wells are at or near historical lows, even for wells with records pre-dating the start of supplemental water deliveries via the Tehama-Colusa Canal in the early 1980s.

4) The total land area within the AOI is about 155,000 acres. Of this, the agricultural area (nearly all of which is irrigated) has been relatively stable from 1990 through 2015 at between 90,000 acres and 95,000 acres. Additionally, about 58,000 acres are classified as native, with minor land areas classified as urban and streams.

5) Permanent cropping in the AOI has doubled, from about 23,000 acres in 1990 to 46,000 acres in 2015, offset by declines in grains and truck crops (tomatoes and melons). Most of these changes occurred in the areas with a mixed water supply or with groundwater only. Areas planted to other crops have remained fairly stable over time.

6) As expected, Net Recharge depends strongly on the availability if supplemental surface water, as summarized below (averages for the period 1990 through 2015):
    a. For the approximately 22,000 acres irrigated primarily with surface water, annual Net Recharge is about +16,000 acre-feet, or +0.8 acre-feet per acre per year.
    b. For the approximately 50,000 acres irrigated with a mixed supply, annual Net Recharge is about -18,000 acre-feet, or -0.4 acre-feet per acre per year.
    c. For the approximately 21,000 acres irrigated primarily with groundwater, annual Net Recharge is about -31,000 acre-feet, or -1.5 acre-feet per acre per year.

7) For the approximately 58,000 acres classified as native, average annual Net Recharge is about 21,000 acre-feet or 0.4 acre-feet per acre per year.

8) The recent, ongoing "Dry" period was defined as 2007 through 2015, inclusive, and the "Normal" period was defined as 1998 through 2006, inclusive. Annual Net Recharge for the AOI over the Normal period averaged +38,000 acre-feet compared to -25,000 acre-feet over the Dry period, indicating an average reduction in Net Recharge of about 63,000 AF per year between periods. This estimated reduction in Net Recharge is of the same order of magnitude as estimated changes in groundwater storage based on DWR groundwater levels.

9) About one-sixth of the reduction in Net Recharge between the Normal and Dry periods is associated with land use (primarily crop) changes, and five-sixths due to "other factors", primarily significantly below average precipitation.

10) "Drought" (beginning in 2007) has had the dominant effect on declining groundwater levels in the AOI, not land use changes.

11) Prognosis:
    a. Current groundwater conditions reflect the accumulation of nine years of generally dry conditions (as well as land use changes)
    b. If "Normal" conditions ensue beginning now (2015-16), it likely will require multiple years for groundwater levels to recover, depending primarily on precipitation amounts and patterns.
    c. The rate of recovery could be hastened by increasing use of supplemental surface water in the mixed use and groundwater use areas, which would allow groundwater pumping to be reduced.
    d. The rate of recovery will be slowed to the extent that recent trends toward relatively high water use crops continue.

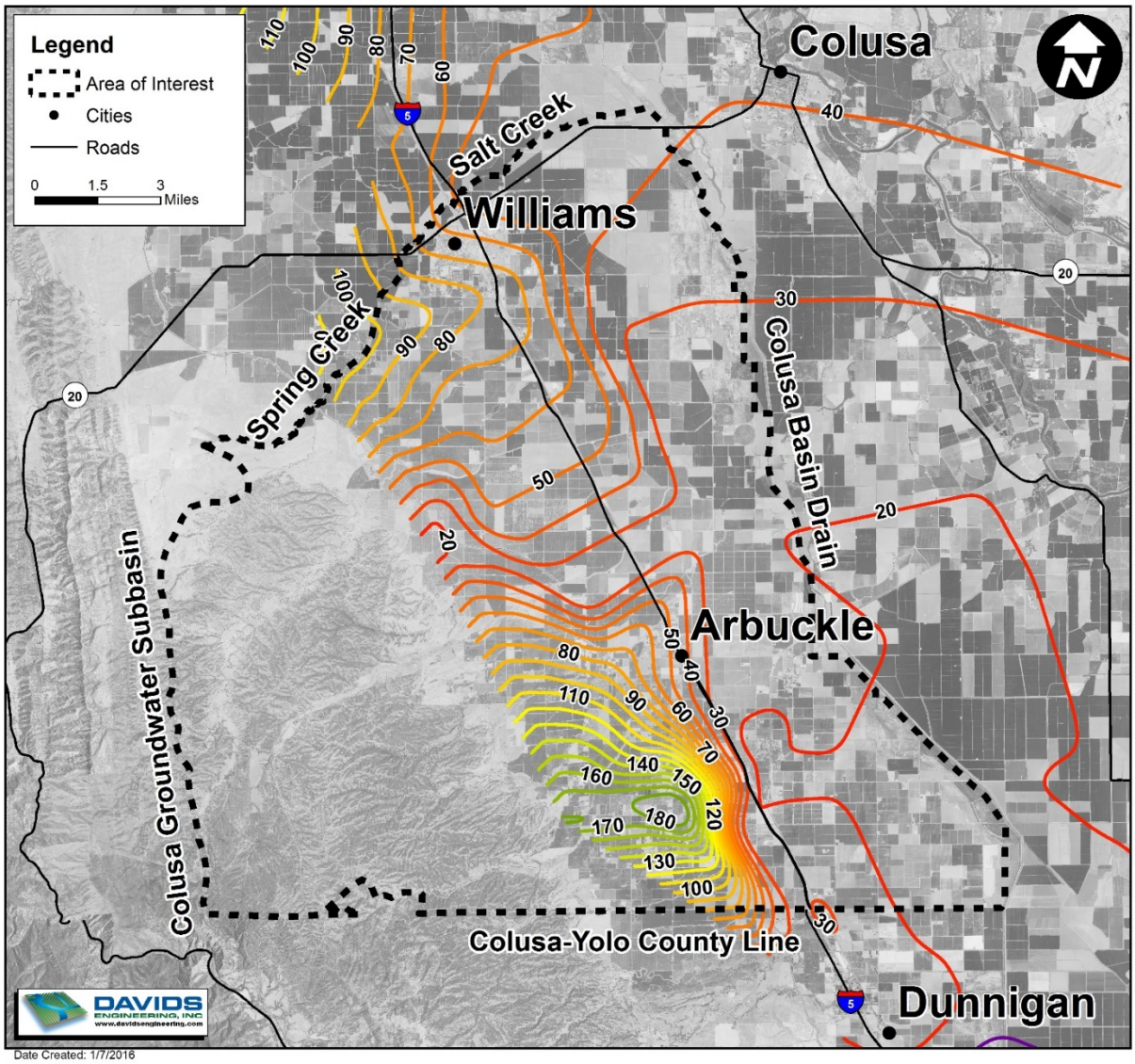

Figure 1. "Area of Interest" Selected for Analysis of Land and Water use in Relation to Groundwater Conditions in Colusa County with 2015 Groundwater Elevations Shown (feet above mean sea level).